Alice and Her Sister Ship, *Carib II*

Part III — The Power Plant and Seagoing Equipment of "Alice"

By Henry Howard

MY first specification for a power plant for offshore cruising was a heavy oil engine and entire absence of gasolene on board. This was principally in the interest of safety. The hazard of gasolene is tremendously increased on a small boat doing offshore work, first, because in bad weather everything must be closed down tight, making good ventilation very difficult. Second, because with the violent motion of a small boat in really rough weather the danger of leaks in tanks and piping is enormously increased.

This subject seems to be more or less taboo, but I am sure there are many who have been made uncomfortable, if not actually sick, by gasolene fumes under the conditions outlined above and perhaps have been afraid to light a fire when the boat was battened down in rough weather. Lately, a friend of mine who is a deep-water yachtsman of long experience, sailed in the ocean race from Larchmont to Gloucester on one of the best new boats in the race. He told me that the gasolene fumes in the cabin were strong enough to be exceedingly disagreeable. This race was not sailed in a storm and presumably it was at no time necessary to close up the boat tightly, otherwise a very dangerous condition might have been created.

***Alice*, in a light fair wind.**

Of course such a condition ought never to occur and it is possible by careful installation and careful operation to reduce the danger to a point where it is almost negligible. However, the most careful installation will not insure safety with careless operation. How much better, therefore, for offshore work, to use the non-volatile Diesel engine oil. With this, even careless operation does not involve an explosion hazard.

As it may be argued that my experience with gasolene engines does not qualify me to speak as an expert, I would simply say that I am a chemical engineer of long experience. I have designed and patented a type of gasolene burner which was used for many years on steam automobiles. I have built and operated a large plant for refining benzol, a material which has frequently been used in engines as a substitute for gasolene. I have made careful studies, in coöperation with insurance experts, to provide safety appliances to minimize the danger in the manufacture and handling of volatile hydrocarbons, and it was because of my intimate knowledge of the hazards involved that I steered clear of any gasolene on a boat to be used by me for offshore work. The risks are, of course, enormously decreased in the ordinary yacht in comparatively smooth water where good ventilation is nearly always possible. For this reason, while I have always been willing to go to sea in a small, well found boat, I have omitted a power plant until small heavy oil engines were available.

In 1921 when I began to seriously study the question, so far as I could find, the American makers of heavy oil engines made nothing as small as 15 brake horse power, which was what I required, with the single exception of the one used by Nutting on the *Typhoon*. I had heard rumors, however, of small reliable heavy oil engines being used by Scandinavian fishing boats. I, therefore, asked the Machinery Division of Bureau of Foreign and Domestic Commerce of the Department of Commerce, Washington, D. C., to investigate the question, and in a few months received through them catalogues and prices from manufacturers in Sweden, Norway, Denmark, Germany and England. A further investigation in Copenhagen developed the fact that most of the Danish fishing fleet at that time was equipped with the Swedish Bolinder engine built in Stockholm. Further investigation showed that the Bolinder Company had been making small heavy oil engines in sizes from 7 h. p. up for the past 25 years and that they had a branch office in New York with a large stock of spare parts and were prepared to supervise the installation.

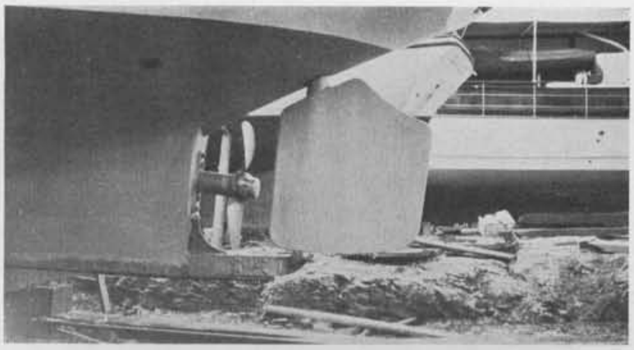
The above facts led me to buy a Bolinder.

I am much pleased to note in the last year or two an increasing number of advertisements of American manufacturers of heavy oil engines and hope that in a few years we may have a good line of American heavy oil engines in sizes from 5 to 20 h.p. In the larger sizes there have, of course, been excellent heavy oil engines of American manufacture for a number of years, but these fill an entirely different field.

The next question was to decide on the size and type of engine.

The following table was very kindly calculated for me by Mr. W. Starling Burgess from the lines of the boat. It is based on operation in smooth deep water with no wind.

Engine room entrance on port, cabin companionway to starboard.



Reversible propeller with blades turned in neutral position.

Reversible propeller with blades turned fore and aft for sailing.

Speed in knots	*Brake Horse Power Estimated*
4	3.7
5	6.0
6	10.5
6.65	15.0
7	19.8
8	45.4

Mr. Burgess thought that under ordinary conditions 15 b.h.p. would give about 6 knots. This calculation was made on the basis of a draft of 3′ 6″, as shown by the lines. Our actual sailing draft, however, is 4′ 0″, when fully loaded with 25 gallons of kerosene, 300 pounds of ice, 287 gallons of water, 300 gallons of Diesel engine oil, 25 gallons of lubricating oil, 2 dinghies, 1 month's food supply and the miscellaneous dunnage brought on board by two ladies and four men. But even under these conditions we were able to average a full 6 knots without sails under favorable conditions; that is, in smooth, deep water with no wind.

Reference to the table will show that beyond 6½ knots the power for this size boat increases very rapidly for a small increase in speed and the cruising radius on a tank full of oil is much reduced. In other words, for a cruising boat with auxiliary power in which the sails are intended to be the principal means of propulsion, 15 b.h.p. is about right.

Henry Howard on the *Alice*.

I next chose a single-cylinder engine for two reasons — first, as I intended to be my own engineer, it would be simpler to keep in order and to overhaul if necessary. It should be remembered that the boat is designed for long cruises, with long periods out of reach of repair shops or competent mechanics. Second, the single-cylinder engine took up considerably less room fore and aft and the room thus saved could be added to my cabin accommodations.

The builders of *Alice*. Right to left, John Brown, Will Brown, George Brown and Merritt Demarest.

The reversible propeller as made by the Bolinder Company is a very rugged affair and is generally used by the Scandinavian fishing boats. It is controlled by a hand wheel on deck by means of which the pitch of the blades can be regulated anywhere from full speed ahead to full speed astern. This seemed to me to have a number of advantages which made it particularly well suited to my wants.

1. In entering uncharted harbors I could proceed very slowly by setting the blades in nearly a neutral position, at the same time my engine would be running at normal speed controlled by the governor. This feature proved most satisfactory in our explorations around the Bahama Cays.

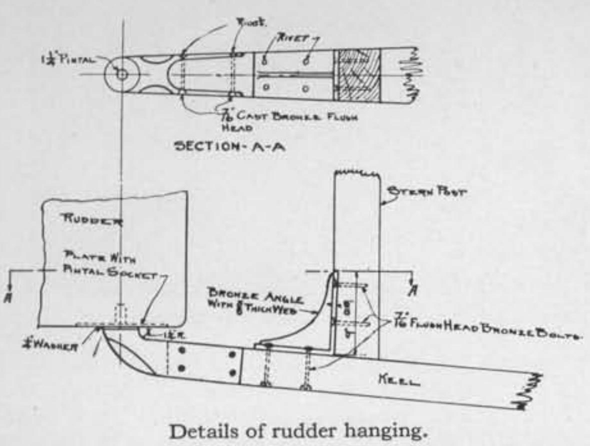
2. When used in connection with sails the pitch could be increased to give the normal number of revolutions while at the same time the engine was developing its full power.

3. When going against a heavy head wind as, for instance, in leaving Hope Town, Bahama Islands, in a strong norther, the channel was too narrow to use sails and the head wind was so strong as to slow us down to about 2 knots. With an ordinary propeller this would have also slowed our engine down thereby seriously reducing its power. By reducing the pitch of the propeller blades, I was able to temporarily increase the revolution to about 10 per cent over the normal, which was safe to do for a short period, and thus ran the engine at above its rated capacity when we needed it badly. As soon as we were in open water we got sails on her and increased the pitch of the blades sufficiently to bring the revolution down to normal. To give actual figures, the diameter of the propeller is 30 inches, normal revolution 450, increased rate referred to, 490 to 500 R.P.M. The velocity of wind was about 35 miles per hour.

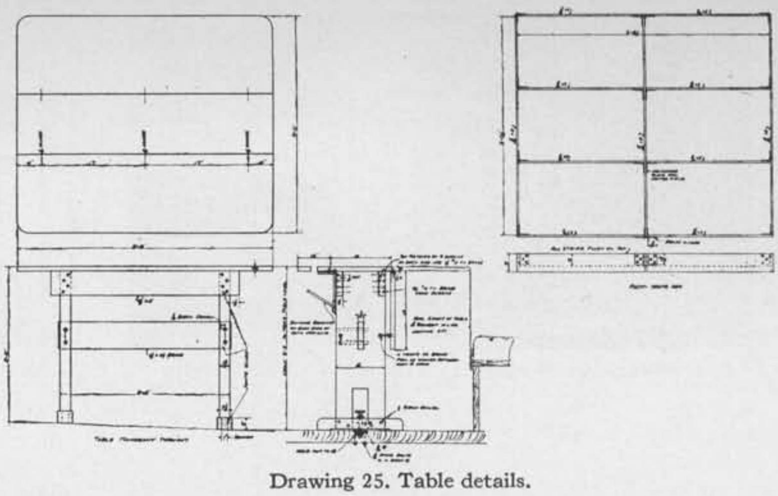
My experience with the Bolinder propeller has been 100 per cent to date, and I would not change it for anything I have ever seen. The following, taken from an August, 1924, issue of the *Yachting World* (English) seems to bear me out in this opinion:

"Reversible or 'feathering' propellers formerly had a bad reputation. The mechanism actuating the blades used to get out of order, and the propeller itself could not be made as efficient as one with fixed blades to which a theoretically perfect pitch can be given. For many years the Scandinavians have been using two-bladed variable propellers which are absolutely reliable and most efficient for auxiliary work.

"The Hein is on much the same lines as all other Scandinavian propellers. The control obtained was perfect, and during two years in which the propeller was in use no adjustment of any kind was needed or appeared likely to be wanted. The characteristics of the Scandinavian type of propeller are its immense solidity throughout. The Hein,



Details of rudder hanging.



Drawing 25. Table details.

for instance, was guaranteed to withstand use in ice, as far as the internal mechanism was concerned. If the shock was great enough it was designed so that the blade should break off at the root, outside the boss, and when coupled to any but a Scandinavian heavy-oil engine probably the crank-shaft would have given out before the blade. In the case of a blade breaking it could be replaced in five minutes, when the ship was on the beach, by removing two nuts which attached the after part of the propeller to the forepart. The blade then slid out, the new one was put in, and the boss bolted together again. The feathering movement is obtained by a fore and aft movement of the whole shaft, which is solid, and has on its after end two bosses which engage with slots in the base of the two blades. The shaft movement is obtained by a screw gear actuated by a chain and sprocket wheel. The thrust block is external, bolted on to the after face of the sternpost. This proved a most satisfactory arrangement, for in addition to the supply of grease from a high pressure grease cup, the thrust was cooled by a constant stream of water. In Danish waters there is often a great deal of sand, and the plunger in the grease cup could be screwed down with such force that the grease oozed out through the thrust as soon as the shaft was revolving, and prevented any possibility of sand finding its way in."

One objection I have heard to a heavy oil engine is that it is apt to emit large volumes of dense, bad smelling smoke. This has not been my experience; in fact, our exhaust is as clear as that of an automobile except for a little steam that shows in cool weather; but unless oversupplied with oil, something that need never occur, it is absolutely smokeless and has no more odor than a properly operating gasoline engine.

Besides the matter of safety, the economy of this type of engine is remarkable. The quality of oil preferred is Diesel engine oil having a gravity of 28 to 34 degrees Beaumé and selling in New York and Norfolk for 8 cents a gallon at retail, delivered in the tanks of the boat. At Miami the price was 10 cents per gallon. In large quantities I understood that this oil is sold for 5 cents per gallon at the oil refinery.

Between New York and Miami we used 264 gallons, or $21.12 worth at the New York price, plus about $5.00 worth of lubricating oil. As we went by the inland water route our sails were of very little use, and as we were in a hurry we used the engine for the entire distance.

Perhaps more important than the saving in cost is the great cruising radius that results from this economy. When running the engine at full load we regularly used 11 gallons in 10 hours, or 1.1 gallons per hour. If we conservatively take 5.5 knots as an average speed this gives 5 miles per gallon, or 1,500 nautical miles for one filling of the tanks. From Perth Amboy, N. J., our starting point, to Miami, is 1,319 nautical miles the way we went, that is, straight from Beaufort Entrance outside to Charleston, S. C. In addition, we had our trial trip in New York Bay and adjusting the compass, about 16 miles, and side trips in Chesapeake Bay, 50 miles, or a total of 1,385 nautical miles. The oil actually used, 264 gallons, equalled 5.23 miles per gallon at 1.1 gallon per hour = 1.1 × 5.23 = 5.75 knots average speed.

We left Perth Amboy on October 21st and arrived at Miami November 22nd. During this period we lay over for sightseeing six full days and seven half days, or a total of nine and one-half days not moving, leaving twenty-two and one-half days during which we were under way. Add to this three nights when we were outside under way we have the equivalent of twenty-five and one-half days' running, or an average of 54.3 miles per day. Except for the outside runs we did not sail before daylight or after dark.

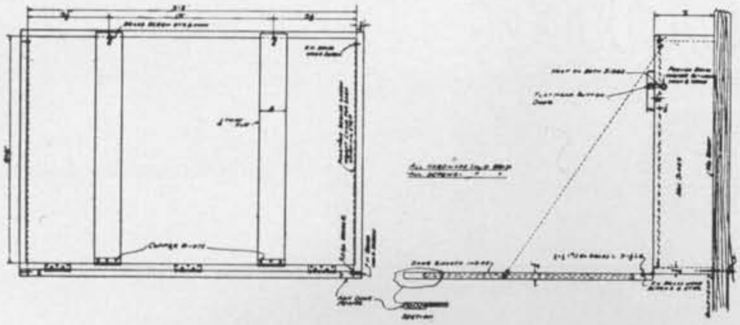
Horse power of Engine. It is easy to talk about having a certain number of horse power in your engine. Generally you accept the manufacturer's rating as given in his catalogue and after the engine is installed there is no easy way of making an accurate test. My engine was guaranteed to give 15 brake horse power at 450 revolutions per minute and, as I wanted to know what it could really do, I arranged to have my representative present at the block test which is given each engine at the factory in Stockholm.

I again went to my friends in the Department of Commerce for advice, and was informed by them that there is an organization known as the Bureau Veritas which is world wide in extent. Its business is to supervise tests of engines, boilers, machinery construction of hulls of vessels, etc.

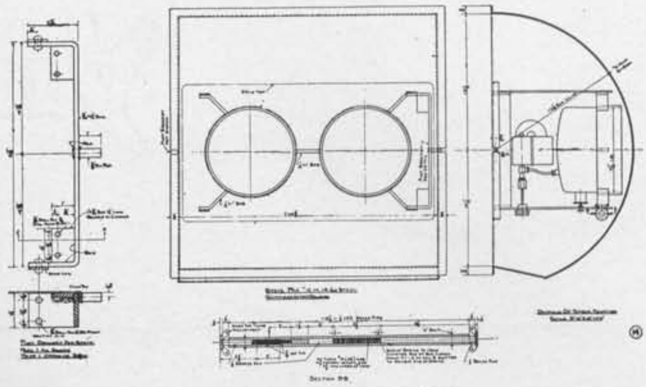
I found that the American office was at 10 State Street, New York, and as they also had an office and a resident engineer in Stockholm, the making of my test was a simple and inexpensive matter. Although the job was a very small one for them, their work was most painstaking and satisfactory. A copy of the data sheet they submitted and which I received before making my first payment on the engine appears at the end of this article.

For the benefit of anyone building a sail or power yacht in any foreign country, I can most strongly recommend the Bureau Veritas to safeguard the owner's interest. In making foreign contracts, it would be well to specify that payments would only be made on approval of Bureau Veritas, who will certify if the progress and quality of the work has been in accordance with the contract and specifications.

Engine Room: A good deal of study was given to this detail and while it is necessarily restricted, it has proved very satisfactory. It is entered by a special companion slide at the after end of the raised deck on the port side. There is no entrance from the cabin, as it was desired to keep out of the cabin all odors of oil and every trace of dirt which might come from the engine or those working around it. A 24″ x 24″ skylight is provided directly over



Drawing 23. Details of chart locker.



Drawing 14. Stove hung in gimbals.

the cylinder so that when it is desired to remove the piston or cylinder a purchase from the mizzenmast head may be conveniently used to hoist it out. The engine room has good head room and a substantial work bench is provided on the port side with heavy machinist's vice and anvil and three large drawers and a cupboard underneath for tools, of which I have a very complete supply — carpenter's, machinist's, pipe fitter's and plumber's, all of which I am fortunately able to use personally with sufficient skill for any repairs that do not require machine tools. This little work shop has been most satisfactory and added much to our pleasure and independence.

The Cabin Layout

A great deal of study was naturally given to this important subject. (See plan in November issue.) The raised deck lends itself to many good cabin arrangements because it gives head room the full width of the boat and makes possible so much light and air. In the break of the raised deck, or what you might call the forward end of the house, are six 6-inch glass air ports; three of these are in the owner's stateroom and three in the galley. The stateroom, which is 12 feet long, has in addition three 8-inch ports on the starboard side and one 24" x 24" skylight giving an ideal amount of light and air. All of the ports are provided with metal covers for use in case the glass is broken. The stateroom has a wide double berth arranged at such a height that when I sit up my eyes come to the center of a port hole, thus enabling me to take a quick glance outside when I am in my berth without going on deck. A large bureau, alcove closet, with pole for coat hangers, gives splendid room for clothing, and a full length plate glass mirror opposite bureau, numerous small lockers over centerboard casing make it very convenient for my wife.

The main cabin or saloon is forward of the engine room bulkhead and aft of the centerboard casing. Its size is about 8' x 12'. It is lighted and ventilated by five 8-inch air ports and one 3' x 3' skylight besides the companion way. It is heated by a tile stove in which either wood or Franklin coal may be burned.

This stove is the greatest comfort imaginable in cold or damp weather. Why more boats do not use them is hard to explain. Thirty-odd years ago they were introduced here by Edward Burgess, of America's Cup Defender fame, and for about ten years were quite generally used, but apparently many of the younger yachtsmen have never seen or heard of them. In a driving northeast summer rainstorm or heavy fog on the New England Coast, it is rather gloomy to be shut up in a small cabin with everything more or less damp and sticky. The effect of a nice open fire in your tile stove is almost unbelievable in the cheerfulness and comfort that results. After a good deal of trouble I discovered that the original patterns developed by Burgess are now in the possession of the Murdock Damper & Bronze Company, 127 Federal Street, Boston, Mass., who will make to order either of two sizes desired, using tile to match the color scheme of the cabin.

The stove pipe is an important detail and as it is very likely to be used for holding on to in rough weather, it should be not only very strong but of double thickness to prevent burning the hands. The outside is made of brass, the inside of copper, with ¼ inch of asbestos between. Iron was not used for the inside pipe as it will rust out so quickly (for details see drawing No. 29).

The cabin has a folding berth on the port side and three book shelves in the corresponding space on the starboard side.

As a general comment on this cabin layout, it will be apparent that no attempt was made to provide for "sleeping the maximum number of people on board." It would have been possible to work in another folding berth in place of the book shelves, and possibly another stateroom.

I think any experienced yachtsman will agree with me that we are not often embarrassed by lack of sleeping accommodations on our boats. The difficulty is to find congenial friends with the time and inclination to go cruising with us. The layout was made with these facts in mind, primarily for my wife and myself, with the possibility of taking two or, on a pinch, three guests with us. And with comfortable quarters for two men in the forecastle.

Cabin Table: A lot of study was given to this detail. At first I planned to use a swinging table but later abandoned this on Fred Lawley's advice because my boat would not heel very much in average breezes. I therefore designed a rigid table with folding leaves, along the lines he recommended, details of which will be found in drawing No. 25. With a rigid table, racks are of course a necessity and the design of a folding rack, shown on the same drawing, has proved most satisfactory. The rack consists of an outer frame of strips three inches wide and the inner strips two inches wide resting on the table. The table cloth is first spread over the bare table and then the rack simply opened up and laid on the table, the three-inch strips extending one inch down all around the edge of the table. Of course, sufficient clearance is allowed for the table cloth around the edges.

The table is held in place rigidly by two substantial thumb screws and screw plates bolted to the floor beams, so it is only a moment's work to detach it when sweeping the cabin floor. Four cast brass swing brackets are provided to hold the leaves opened when desired. All the hardware for the table may be obtained from Geo. Lawley & Son Corporation, Neponset, Mass.

Chart Locker: The main thing in storage of charts is,

(*Continued on page 98*)

Alice and Her Sister Ship, *Carib II*

(*Continued from page 53*)

first, an arrangement that will allow you to locate any chart you want at a moment's notice and, second, to keep them flat, not rolled up, so that they are always in good shape to work with. Of course, large drawers are excellent for this purpose but in a small boat the amount of room required can generally be used to better advantage. On my last two boats I have used a locker, details of which are shown in drawing No. 23. The specifications are as follows:

Chart Locker: Built onto after bulkhead as shown, inside dimensions 3′ 2″ wide, 2′ 3″ high, 7″ deep. Frame of ¾″ ash securely fastened to bulkhead by long round headed brass screws through washers from engine room side. The front to be full size of locker 3′ 2″ x 2′ 3″ very strongly hinged at lower edge. Door framed of ash with panels of white pine. Panels to be flush with frame on inside so that when the door is opened to horizontal position, it will present a smooth surface suitable for a chart table. This door or chart table to be held horizontal by strong brass safety chains and to be held shut by a stout spring latch.

This locker will hold any of the United States charts I have seen with only one fold in the middle. The size shown in the drawing will hold all the 1-80,000 charts from Eastport to Key West, plus all the smaller scale coast charts covering the same district, plus all the Atlantic Coast harbor charts and quite a bunch of West Indies charts besides. The hinged battens hold the charts that are not being used securely in place while the two or three charts that are wanted for the next few days lie next to the hinged door which also serves as a chart table. For classifications of the charts I use folders a little larger than the largest charts and made of the heaviest obtainable manila paper. The folders are plainly labeled.

Bureau Veritas test of Bolinders Engine.

For testing a 15 b.h.p. Bolinders motor, consigned to Mr. Henry Howard. Date of test, 1st of February, 1924. Manufactured by J. & C. G. Bolinders, Mek. Verkstade A/B, at Stockholm. Type, single-acting, 2-cycle, serial No. 15031. Number cylinders, 1; bore, 190 mm. (7½″); stroke, 210 mm. (8¼″). Rated, 15 h.p. at 450 r.p.m., throttle graduations. No. Readings Taken Every 10 Minutes, Fuel, B. T. U., per lb. (T) 16740. Gravity Beaumé, 0.86 at 57.2 F°. Dynamometer arm in inches, (R) 18″. Constant (C) 3501.3. Test started, 2:15 P.M. Test completed, 3:15 P.M. Duration of test, 1 hour. Weight of fuel, start, 10,000 grammes. Weight of fuel, stop, 5,860 grammes. Total fuel consumption, 4,140 grammes = 9.127 lbs.

Observations	*Symbol*	*Formula*	*Start* 2:15 P.M.	*1* 2:25 P.M.	*2* 2:35 P.M.	*3* 2:45 P.M.	*4* 2:55 P.M.	*4* 3:05 P.M.	*6* 3:15 P.M.
Load on brake, lbs.	P		116.85	116.85	116.85	116.85	116.85	116.85	116.85
Load in per cent.			100	100	100	100	100	100	100
R. P. M.	N		448	448	450	453	452	450	450
Lubricating oil F°						Not measured			
Lubricating oil pressure						Not measured			
Inlet water F°			68	68	71.6	71.6	69.8	75.2	75.2
Outlet water F°						Not measured			
Exhaust gas appearance						Pure and uncolored			
Exhaust gas F°						Not measured			
Test room, F°						Not measured			
Barometer						Not measured			
Thermal efficiency		$\frac{2545}{F \times T}$	Average, 0.2502.		Guaranteed, 0.2142				

Total Averages: r.p.m., 450; b.h.p., 15.02; fuel per b.h.p. hr. lbs., 0.607; fuel per hr. lbs., 9.127.

Remarks: Oil consumption at 10 b.h.p. (1 hour's test). Load on brake, lbs. 77.16. Averages: r.p.m., 452; b.h.p., 9.96; fuel per b.h.p. hr. lbs., 0.73. Fuel per hour, lbs., 7.275. Inlet water F°, 70.3. Overload test and corresponding fuel consumption (½ hour's test), load on brake, lbs., 123.5. Averages: r.p.m., 454; b.h.p., 16.01; fuel per b.h.p. hr. lbs., 0.606; fuel per hour, lbs., 9.7; inlet water F° 86.0. Motor run during 45 minutes without load with satisfactory results, the average temperature of the cooling water being 89.6 F°. Lubricating oil consumption measured during 95 minutes at constant r.p.m. of about 450 and found to be 0.334 lbs. per hour. This engine has been tested and inspected according to the contract and, in our opinion, based on our experience and judgment, is within the stipulations of said contract.

BUREAU VERITAS. F. STANLEY STARLING, CHIEF SURVEYOR.

(*To be concluded*)